N E W S L E T T E R

CLOVERS AND SPECIAL PURPOSE LEGUMES RESEARCH

Vol. 2--1968

Compiled by the Forage and Range Research Branch, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland

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INTRODUCTION

The original objectives of the Clovers and Special Purpose Legumes Research Newsletter was the informal exchange of research information on the many species of forage legumes other than alfalfa. Our experience through this issue, the second volume, dictates no change in this objective.

The contents of each volume are those contributions, compiled without editing, that research workers submit voluntarily. We do encourage the future use of this medium for the exchange of research information not available via other media. We hope that the Newsletter replaces, in part, the absence of Research Conferences with the many species involved. In this spirit we solicit periodic overall reviews of research programs with the species with which you work.

We welcome your contributions and suggestions in future issues of this Newsletter.

R. C. Leffel

Reports and other information for the next issue may be sent to Paul R. Henson, Room 337, South Building, Plant Industry Station, Beltsville, Maryland 20705

CALIFORNIA

Publications:

Williams, W. A. 1967. The role of the Leguminosae in pasture and soil improvement in the neotropics. Trop. Agr. Trin. 44: 103-115.

Williams, W. A. 1967. Seedling growth of a hypogeal legume, Vicia dasycarpa, in relation to seed weight. Crop Sci. 7: 163-164.

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CANADA

Uniform Regional Birdsfoot Trefoil Test, Western Canada, 1967

B. P. Goplen (Saskatoon, Sask.)
(Cooperators: A. K. Storgaard, D. A. Cooke, W. L. Crowle, D. H. Heinrichs, P. Pankiw, H. Baenziger, W. A Hubbard, V. G. Peterson)

Summary of 1967 Results

1. On the basis of results to date there is little to choose between Lec and Saskatoon Composite. Empire yields almost as well but is somewhat less winter hardy.

2. MC-R-64 and MC-F-65 are superior in seedling vigor. Further evaluation is necessary to assess these promising strains.

3. Winnar appears superior in the limited forage and seed yield data so far and should be tested more extensively.

4. Viking is less winter hardy and consequently yields less forage and seed. It does, however, serve as a useful check for winter-killing data.

5. The overall average shows trefoil to produce 80% of the forage yield of alfalfa.

Table 1. 1967 Forage Variety Co-operative Performance Trials in Western Canada. Yields in % of Empire with Actual Yields of Empire Tons DM/Acre in Brackets.

Location	Winnipeg Eriksdale	Winnipeg Grunthal	Winnipeg Melfort	Winnipeg Saskatoon	Scott	Swift Current		Beaverlodge		Lacombe	Kamloops	Prince George	Smithers	All sca. avg	No of sca
Year Seeded	1965	1965	1966	1965	1965	1965	1966	1964	1965	1966	1965	1964	1964		
No. of Cuts	1	1	1	2	1	3	3	1	1	2		1	1		
Variety															
Empire	(1.05)	(2.70)	(1.39)	(3.60)	(.40)	(2.88)	(3.54)	(1.35)	(1.49)	(1.90)	(4.22)	(.40)	(1.30)	(2.02)	13
Fargo	107	91	106	92	97	103	104	101	106	102	85	95	91	94	13
Leo	116	111	98	103	112	96	85	119	109	108	111	75	98	102	13
Viking	99	104	88	83	82	78	81	77	85	48	98	85	109	84	13
Synthetic Comp.	108	94	98	91	105	103	97	99	107	109	95	97	109	99	13
Winfax	103	99	105	97	105		95		107	112	89			109	9
MC-B-64	122	111	95	99	208		87		89	94				99	8
MC-F-65			85				88			111				106	3
Beaver (alfalfa)	166	152	137	109	202	134	121	87	87	135	119	100	102	124	13
Mean	108	101	86	95	113	96	93	99	100	98	96	90	102	100	
Trefoil/ alfalfa	65%	67%	62%	87%	56%	70%	77%	114%	115%	72%	81%	90%	100%	80%	

Table 2. Uniform Regional Birdsfoot Trefoil Test. 1967 Data.

Seed Yield in lb/acre.

Station Yr. seeded	Melfort 1966	Swift Current 1966	Beaverlodge 1964	Beaverlodge 1965	Lacombe 1966	All-station average	No. sta.
Empire	528	455	196	103	484	353	5
Fargo	440	489	177	121	432	332	5
Leo	381	495	141	118	446	316	5
Viking	214	24	199	67	127	171	5
S'coon Comp.	547	439	209	162	522	376	5
Winnar	652	438		169	640	475	4
MC-E-64	419	380		93	272	291	4
MC-E-65	450	439			390	426	3
Beaver (alfalfa)	209		62	24		98	3
Mean (trefoil)	454	422	184	119	414	342	

Comments from individual Stations

Eriksdale. The Eriksdale test was badly infested with volunteer sweetclover, alfalfa, and grasses. In spite of this, however, the results generally conform to expected with MC-H-64 and Leo somewhat higher yielding, although not at a significant level. Alfalfa outyielded the trefoil varieties (P = .01).

Grunthal. In the Grunthal test the first replication was not harvested due to gopher damage. In this test again MC-H-64 and Leo appeared to be the top forage yielders with Viking next in line. Alfalfa was again yielding about 35% more than the trefoil varieties

Melfort. MC-H-64 and MC-F-65 appear to have superior seedling vigor. Winnar, Fargo, S'toon Comp., and Empire are highest in forage yield, although alfalfa yields significantly more (P = .05) than all trefoil varieties. Winnar, S'toon Comp., and Empire are highest in seed yields. Viking shows considerable winter injury in its low forage and seed yields.

Saskatoon (Outlook-irrigation). Viking is showing some loss of stand as expected from winter damage, and this probably accounts for its poorer spring stand and lower forage yields. The test will be maintained for 1968 data.

Scott. Viking is lowest yielding probably a result of winter injury. Strain MC-H-64 appears most promising.

Swift Current (1965 test). Basal ground cover was recorded in May 1967. Forage cuts were taken on June 27, Aug. 9, and Oct. 11. Stands in this test are good for most entries, but some are yielding less because of winter injury (i.e., Viking).

Swift Current (1966 test). This test had one of the most uniform stands of any tests established of this crop. Forage cuts were taken June 25, July 26, and Oct. 10. Alfalfa outyielded all trefoil varieties. Empire, Fargo, S'toon Comp., and Winnar were the best forage yielders. Honey bees pollinated the crop well but set negligible seed on alfalfa. Growth was rank on the seed test but still produced a good seed crop.

Beaverlodge (1964 test). Leo is highest and Viking lowest in forage yield. Viking is earliest to flower and set seed.

Beaverlodge (1965 test). Viking and MC-H-64 were lowest in forage and seed yield. Winterkilling occurred in all varieties, reducing their forage and seed yields.

Lacombe. Viking is less hardy than the other trefoil varieties and this is reflected in seed and forage yields. Although somewhat higher in forage yield, alfalfa does not significantly outyield the better trefoil varieties. Strain MC-H-64 performed only moderately well in contrast to its superior performance at most other stations.

Kamloops Leo was the higher forage yielder. Alfalfa yielded significantly more forage than the trefoil varieties.

Prince George. Because of infestation with timothy, hand separation was carried out, and trefoil yields were based on estimated trefoil component. In the test area, Leo and S'toon Comp. appear to persist the most.

Smithers. In the spring, 100 pounds of 16-20-0 was applied. Trefoil appears better adapted to the area than alfalfa.

Comments on New Strains and Varieties Tested

Leo. Refer to Canad. J. Plant Sci. 44(2):219-220. 1964

Saskatoon Composite '58. A composite of winter-hardy strains developed at Saskatoon. This project started in 1950 when four introductions of Lotus spp. were obtained from Ottawa. Of these four introductions, only one (S-3505) survived the two subsequent winters. This strain and 11 strains from Macdonald College were seeded in a 2-replicate test in 1952. In 1954 the O/P seed of the surviving strains was used for a single-plant nursery of 1,000 plants. About one half of these plants survived the following two winters. Based on winter survival and other agronomic factors, such as date of flowering, habit of growth, and vigor, about 50 single plants were selected and O/P seed was collected. These 50 O/P selections were seeded in a 3 replicate single row progeny test. The winter of 1957-58 was very mild and survival was 100% in this test. During the summer of 1958 the lines were so uniform that few agronomic differences were observed among them. Hence the seed was harvested in bulk and labeled as 'S'toon Comp. '58'. Two sub-sequent seed increases have been made, and approximately 125 pounds of seed are currently on hand.

Winnar. A strain or local ecotype from Winona, Minn. This strain is maintained by the Plant Materials Center, Pullman, Wash. Information on this strain was supplied by L. R. Stoa in a letter dated March 25, 1964, and is given as follows:

> "The birdsfoot trefoil you refer to in your letter of March 23 is our accession P-15456. It was sent to us in 1953 from Winona, Minn., with the number M4 19934. Originally this accession came from an indefinite location in New York. Our present stock is one generation removed from the Winona seed.
>
> "The outstanding attribute of this trefoil is its winterhardiness. This was shown to us during the 1962-63 winter when 18 accessions in our initial observation plantings were severely winter-damaged, including the Canadian variety "Leo." P-15456 was completely free of any winter-damage. Other favorable characteristics include good seedling vigor, very rapid establishment, good forage production, and good seed production. It has tentatively been named "Winnar" but has not been released or certified."

Mc-M-64. A strain of trefoil developed by J. S. Bubar, Macdonald College, Montreal, Quebec. For information on this strain refer to: Clovers and Special Purpose Legumes Research Newsletter 1:3, 1967.

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GEORGIA

The Mode of Pollination in Blue Lupine (Lupinus angustifolius L.) at Tifton, Georgia

Ian Forbes, Jr. (Tifton)

Research on the mode of pollination in blue lupine indicated that early-maturing Rancher blue lupine was 100% self-pollinated at Tifton in 1967, as was another early-maturing line in similar previous research (1953 and 1954). Many other observations during breeding operations have led us to expect complete self-pollination in blue lupine at Tifton. However, in 1966 a small number of out-cross seedlings was observed in nursery plantings of 14 late-maturing winterhardy elite lines. In the 1967 test, designed to give the maximum measurable (identifiable) amount of cross-pollination, all of the 14,393 Rancher seeds harvested resulted from self-pollination. In contrast, among 10,429 seeds harvested from late-maturing line 65G-251, 15 (0.14%) resulted from cross-pollination, the rest being selfs. Since blue lupine breeding and improved variety seed increase methods in the Southeast in the past have been based on the premise that blue lupine was virtually 100% self-pollinated, this information will result in important changes in both methods.

The current discovery of a low rate of cross-pollination in late-maturing blue lupine at Tifton led to a cooperative survey of insect visitors of blue lupine flowers in 1967 at Experiment, Tifton, and Valdosta, Georgia, and at Gainesville, Florida. Species of the Hymenoptera, especially the honeybee, were the most abundant of the insect visitors. The honeybee and bumblebee gather pollen from the blue lupine flower by wing petal depression. The bumblebee, especially queens, may cause severe flower damage by splitting the keel petal. Thus the stigma becomes permanently exposed to foreign pollen carried by smaller, flower-visiting, pollen-collecting insects.

Publications:

Forbes, Ian and Homer D. Wells. 1967. Registration of Rancher blue lupine (Reg. No. 2). Crop Sci. 7:273.

Forbes, Ian and Homer D. Wells. 1967. Inheritance and epistasis of white-background testa-color in blue lupine (Lupinus angustifolius L.). Agron. Abstr. (1967 Annual Meetings of Amer. Soc. of Agron., Washington, D. C., Nov. 5-10), p. 9.

Minton, Norman A. Ian Forbes and Homer D. Wells. 19[illegible]. Susceptibility of potential forage legumes to Meloidogyne spp. Plant Dis. Rptr. 51(12):1001-1004.

Wells, Homer D. and Ian Forbes Jr. 1967. Effects of temperature on growth of Glomerella cingulata in vitro and on its pathogenicity to Lupinus angustifolius genotypes ar ar and An Ar. Phytopathology 57(12):1309-1311.

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IOWA

Establishment of Birdsfoot Trefoil and Crownvetch

D. R. Buxton and W. F. Wedin (Ames)

The objectives of this study are to investigate the effect of several methods of establishment of birdsfoot trefoil and crownvetch on subsequent yields, root development, stand, and carbohydrate levels. Five different methods of establishment were used, four spring seedings and one summer seeding. Two of the treatments employed oat companions of contrasting canopy types: one with short erect leaves and the other with large drooping leaves. The third treatment was a check in which weeds were allowed to compete with the legume. In the fourth treatment the forages were hand-weeded twice prior to the end of June. The forages were planted August 10 after a crop of oats had been harvested in the final treatment.

Two identical experiments are being conducted. The first experiment was planted in 1966, harvested twice that year and three times in 1967. The second experiment was planted in 1967 and is currently in progress.

Light readings were taken at approximately weekly intervals under the two oat companions commencing the forepart of June. Readings were taken by integrating light meters made of booklets of photosensitive Ozalid paper. The amount of radiation that penetrated through the 1966 seeding year oat companion canopies was significantly different although the two canopies produced similar amounts of dry matter.

The two harvests taken the seed year of 1966 indicated that the erect companion did not result in better yields. There was greater amount of weed growth with this treatment.

Weed competition was comparatively mild during this experiment although it was of such a magnitude to reduce yields of the non-weeded check to 1/3 of the weeded plots in the first harvest of the seeding year. The late summer of 1966 was extremely dry, and only the weeded plots made significant regrowth by the time the fall harvest was taken.

Commencing with the second harvest of the seeding year and with all subsequent harvests, the roots of both legumes were harvested from a subsampled area at the time the forage was harvested. Counts were made of the number of plants. The roots were cut to a length of 6 inches below the lowest node. After the roots were dried, they were weighed and used as samples for total available carbohydrate (TAC) determinations.

Yields of the three harvests in the first production year (1967) showed that the weeded treatments far out-yielded the other treatments. Non-weeded treatments yielded less than 1/3 of the weeded plots with the exception of the summer planting of crownvetch. In this case the yields were about 1/2 of the weeded plots.

The establishment treatments had marked effects on the stands of the two legumes. The weeded plots resulted in significantly higher stands of birdsfoot trefoil than any other treatment. However, with crownvetch the late summer planting resulted in stands that were three times as dense as the weeded treatment. Because of the dry fall the year of seeding, very little crownvetch seed germinated from the late summer seeding. The vernalization treatment the seed received during the winter resulted in a high percentage germination the following spring.

Root weights during the year following establishment were affected by establishment treatments in manner similar to the forage yields. However the activity of the root area may be affected more than would be indicated by the reduction in forage yields. This conclusion was supported by the carbohydrate percentages which were lowest for the highest yielding plots. Based on the hypothesis that minerals and water from the roots have little effect on the rate of photosynthesis but exert their influence in the use of carbohydrates for the growth processes, the level of TAC is a measure of the internal balance between the activity of the tops and roots. The higher level of TAC in the non-weeded plots indicates a relatively low activity of the root system compared to the tops.

Leaf Area, Dry Matter Production, and Carbohydrate Reserve Levels of Empire Birdsfoot as Affected by Cutting Height

Scott T. Croush and W. F. Wedin (Ames)

One-year-old stands of Empire birdsfoot trefoil were cut to 1½, 3, and 4½ inches to leave three different residual LAI values. Weekly data were obtained on LAI, dry matter yield, and total available carbohydrates (TAC) of roots and crowns during 7 weeks of regrowth in early summer (Period I) and mid- to late summer (Period II). Period I began in early June and Period II began in mid-July. Results for Periods I and II were generally similar except that leaf and dry matter yields were lower for Period II.

There was no significant difference in net dry matter increase between the 3- and 4½-inch treatments. The 1½-inch treatment yielded significantly lower than the other two. There was evidence that the 3- and 4½-inch treatments accumulated LAI at a faster rate than the 1½-inch treatment during the second and third weeks of regrowth.

TAC levels in the roots and crowns decreased as severity of defoliation increased even though initial root TAC levels at time of cutting were only 3 to 5% of dry weight. Crown TAC levels were generally about one-half those of the roots but responded in a manner similar to those of the roots.

Disease incidence in the 1½-inch treatment further reduced LAI and yield of that award during Period II but was not present during Period I.

The results of the study indicated that residual leaf area does not contribute substantially toward increased dry matter accumulation during regrowth of trefoil. However cutting at 1½ inches reduced net dry matter accumulation during regrowth, possibly because too many of the more active axillary buds were removed.

Effects of Defoliation Frequency on Improved Birdsfoot Trefoil Varieties

W. F. Wedin and C. P. Wilsie (Ames)

Birdsfoot trefoil acreage has been increasing steadily in southern Iowa. However, some farmers have experienced stand reduction or complete loss of stand. In several instances root rot infections have been observed as primary causative agents.

With an need increase for trefoil in southern Iowa, we have started a small management study wherein three promising selections and Empire will be under test in 1968 at the Shelby County Experimental Farm, Shelby, Iowa. Entries in the test are Dawn (Missouri), R-1 (a selection for large seed in a Russian strain, Acc. No. 3019), E-1 (a selection for large seed in Empire, Acc. No. 3020), and Empire. Two harvest frequencies will be used with data on yield and quality of forage and persistence of stand of primary importance.

Grazing Intensity for Emerald Crownvetch

W. F. Wedin and R. L. Vetter (Ames)

Eighteen acres of Emerald crownvetch were established at the western Iowa Experimental Farm, Castana, Iowa in 1967. Satisfactory stands were obtained. Weed control was partially effective because of Eptam application immediately prior to seeding. Beginning in 1968, replicated pastures will be grazed at various intensities to provide a range in grazing pressure. Animal output per acre and persistency of stand are primary items to be studied over a 3-year period.

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Birdsfoot Trefoil vs. Reed Canarygrass (+ N) for Beef from Pasture

W. F. Wedin and R. L. Vetter (Ames)

Empire birdsfoot trefoil (BFT) and reed canarygrass (RCG) were seeded in pure stands, three replicates each, in 1964. Yearling steers grazing on these pastures in 1965, 1966, and 1967 received grain or no grain as follows. The following table indicates animal performance and acre output.

Table 1. Steer gains (lbs.) for yearling steers grazed on birdsfoot trefoil (BFT) and reed canarygrass (RCG). Shelby County Experimental Farm, 1965, 1966, and 1967 averages.

	Pasture Only		Pasture + Grain[1]	
	BFT	RCG	BFT	RCG
Length of grazing season, days	138	147	153	170
Animal days per acre	214	293	316	462
Average daily gain, lb	1.46	1.47	1.70	1.94
Gain per acre, lb	318	378	444	895
Feeding rate (grain)	1.10	1.82	2.06	2.66

[1] Ranged from 21 to 25 bushels per steer per year or with an average of 10 to 12 lbs. per day fed for the pasture season.

[2] Two year average only (1965-66).

The lower yielding ability of the BFT pastures, coupled with their shorter season causes proportionately lower animal days per acre. This reflects on the average stocking rate per acre which the various pasture treatments could carry. From 1.70 to 2.66 steers per acre can be carried for the length of season specified. The excellent carrying capacity of RCG is shown, particularly when the season is extended, as on RCG + grain, to a 170-day average over the 3 years.

Average daily gain values indicate better performance of RCG alone than on BFT alone (1.47 vs. 1.26). It should be mentioned here that previous work with BFT pastures at the same station showed ADG values of 1.66 lbs for yearling steers grazing on predominantly BFT pastures over a 6-year period. These same pastures, as continued, provided forage to realize ADG values of 1.89 lbs in 1967. The botanical composition of these longer term pastures is BFT, bluegrass, and white clover. Very few weeds are present, and thus, although actual BFT percentage is not as high, the pastures are productive and animal performance has been excellent over the entire period. The lowered ADG and beef per acre output on BFT alone in the present BFT-RCG study may reflect that weeds are a problem in the pastures. Because of the high fertility used in the present experiment, it may be that weeds are too competitive with BFT, and overall production and performance is lowered.

It should not be concluded that BFT can not be successfully grown under high fertility conditions, but rather that it may be necessary to have first-rate stands, keep weeds to a minimum, and bring sufficient grass into the mixture to prevent weeds taking over and subsequently reducing overall pasture and animal production. This may be all true, because BFT is noted as a poor competitor and, under low or medium fertility, competition from other pasture legumes or grasses is minimized. However, under high fertility, the lowered competitive ability actually becomes a drawback, and unless desirable grasses are seen, weeds enter.

Beef per acre values presented show excellent results for RCG alone, and RCG + grain, RCG + grain shows a 200 lb per acre advantage over BFT. Having fertilized the RCG with 120 lbs of N per acre, the relative net return of the RCG + grain over BFT + grain while on pasture can be estimated.

Because of the excellent carrying capacity of the RCG pastures and the performance of cattle grazing on them, we are encouraged to suggest this versatile forage for both upland and lowland areas. RCG as used in this study is on upland sites.

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KENTUCKY

Plant Physiology Studies With Red Clover

W. A. Kendall (Lexington)

Growth of red clover pollen through excised pistils. The general techniques and some results of this research were reported in the Newsletter for 1967. During the past year it was observed that several plant hormones at high concentrations inhibited pollen growth with compatible matings and did not retard the incompatibility mechanism. Application of high temperatures to the flower heads during the period of anthesis retarded the incompatibility mechanism. This temperature treatment affected the styles and not the pollen. In one of three experiments the application of relatively large amounts of pollen to the stigma rendered the incompatibility mechanism less effective.

Seed production on excised flower stems. The general techniques and some results of this study were reported in the Newsletter for 1967. In recent studies it was observed that boric acid may not be essential in the medium, especially if the flower stems were excised from vigorously growing plants; i.e., plants producing many flower heads. If the plants were not vigorous, then boric acid, calcium nitrate, and streptomycin sulfate at 50, 100, and 250 ppm enhanced anthesis. The temperature treatments used to partially prevent self-incompatibility were changed from the procedures previously reported. In the new method the flower parts are held at 40 C with their stems at 25 C during anthesis, and the stems and flowers are both held at 20 C for pollen tube growth and seed maturation.

Publications.

Kendall, W. A. 1967. Growth of red clover pollen. II. Elongation in vitro. Crop Sci. 7:342-344.

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MARYLAND

Scarifying Small Lots of Crownvetch Seed

Paul R. Henson and Lester A. Tayman (Beltsville)

Plant breeders working with crownvetch are faced with the problem of uniformly scarifying small lots of seed, as from single plants. While crownvetch seed is difficult to hull by hand, small to large quantities are readily hulled in commercial hullers where seed in the pod is passed between rubber covered rollers turning at different rates of speed. Seed so hulled is not scarified. Various lots hulled in the above manner have a quick germination value of 5 to 20%.

Hand scarification by rubbing seed between sheets of coarse emery paper improves germination, however, it is not possible to uniformly scarify a series of seed samples. Also, to secure a reasonably high percent of quick-germinating seed, we believe we destroy many of the large seed and leave the very small seed unscarified.

A small scarifier, secured through Dr. L. J. Elling, constructed in the mechanical shops at the University of Minnesota was used in the scarification studies reported herein. The scarifier consists of a drum 4½ inches in diameter and 4 inches deep with the inside covered with coarse emery paper. The bottom part of the scarifier is tapered for removal of seed. Scarification is obtained by blowing seed through a 3/8-inch tube into one side of the emery-lined drum. The air tube carries a pressure gauge, a cutoff valve, and a slanted funnel-type opening for introduction of seed into the air stream. The top cover of the scarifying drum is perforated to allow air to escape. Operational tests indicate that under 40 pounds of pressure approximately 80% of a 5-gram sample of crownvetch seed will remain in circulation in the scarifier.

Two methods of scarifying four crownvetch seed stocks were studied. In Method A, 5-gram lots of each seed stock were held in the scarifier for 30, 60, 90, and 120 seconds. In Method B, we attempted to study the effect of the impact of seed against a rough surface on germination. Six samples of 500 seed of each seed stock were tested. The procedure followed was to cut off the air immediately after dropping seed into the air stream entering the scarifier. Samples of each seed stock were put through the scarifier 1, 2, 3, 4, 6, and 10 times. Forty pounds air pressure was used throughout these studies.

The four seed stocks of crownvetch studied were:

1. Emerald--secured from the USDA Plant Materials Center, SCS, Lansing, Michigan on January 30, 1968. This seed had been hulled and lightly scarified with a hammermill; total germination was 86%, with 52% hard seed.

2. Penngift--secured from Stanford Seed Company of Philadelphia, Inc., October 11, 1967. Total germination was 69%, with 23% hard seed.

3. and 4. These were seed stocks from two locations at Beltsville produced in 1965 and 1966. Seed had been hulled between rubber-covered rollers.

The germination test consisted of 4 replications, 100 seed each, arranged as a randomized block, planted in soil in flats in the greenhouse. The test was planted February 29, and emerged plants were counted on March 7 and 13, 1968. The results of the germination test are shown in the accompanying table.

Effect of Methods of Scarification on Germination of Crownvetch Seed

Treatment	Emerald	Penngift	Hay 39,713	Pasture 37,914	Average	
			Average % Germination			
None	35.5	53.3	19.5	15.3	30.9	
Time in scarifier			Method A			
30 seconds	49.3	76.8	57.3	66.3	62.4	
60 "	54.5	69.3	65.5	56 5	61.4	
90 "	56.8	73.0	66.3	63.5	64.9	
120 "	48.8	78.8	67.3	73.0	66.3	
Average	52.3	74.4	64.1	64.8	63.9	
Times through scarifier			Method B			
1	64.8	80.3	75.5	87.5	77.0	d
2	81.8	90.3	86.5	90.3	87.2	abc
3	86.5	93.5	89.8	91.3	90.3	a
4	79.5	92.0	90.5	91.3	88.3	a
6	85.9	92.5	82.0	89.8	87.5	ab
10	80.0	91.5	74.3	89.8	83.9	bc
Average	79 7	90.0	83.1	00 0	85.7	

All methods of scarification significantly increased germination. The percent germination of seed lots held in the scarifier for 30 to 120 seconds were not significantly different. Since broken and badly damaged seed were not included in the germination tests, the data do not show losses due to overscarification.

In evaluating the effect of 1 to 10 impacts of seed into the scarifier, significant differences in germination occurred. One time through the scarifier gave very good germination but significantly less than 2 to 6 times. Since each lot started with 500 seeds, we were able to get an estimate of seed damage by germinating the remaining sample after the 400 seeds were germinated. While we expect that some seed were inadvertently lost in handling, apparent damages to seed increased from 2% for 1 time through to 15% for 10 impacts.

The results indicate that for scarification of small seed stocks in a breeding program, the impact-type of scarification appears to be quite satisfactory. It should be pointed out that all seed stocks used in the above tests were undoubtedly low in seed moisture as they were more sensitive to scarification than locally produced seed stocks we have studied.

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Red Clover Research

R. C. Leffel (Beltsville)

All available Plant Introductions of red clover were established in a spaced-plant nursery in the fall of 1964 and again in a rod-row nursery in the fall of 1965 at Beltsville, Md. Bulk populations designated as early-, medium-, or late-flowering red clovers tracing to appropriate selections made in the 1964 nursery, as well as bulk seed from all 1965 survivors of the 1964 nursery, are available for experimental purposes upon request.

Field persistence in the 1965 nursery (evaluated fall of 1967) was superior for the following Plant Introductions--and selections therefrom--and Breeder strains: P.I. 193,295*, 231,781*, 232,104, 233,828, 233,829, 234,446, 234,447, 234,928, 235,872, 235,873, 236,612**, 237,194, 237,195*, 237,196*, 237,284*, 239,697*, 239,700, 239,701, 251,564*, 260,251*, 286,115, Illinois #1, Illinois #2, and Kentucky Synthetic A-2.

(*--designates selection from the P.I., via Geneva, N.Y., as actually tested but seed of selection no longer available.
**--increase of selection redesignated as P.I. 303,830 and available.
All Introductions available from Dr. Des Dolan, Regional Plant Introduction Center, Geneva, New York 14456.)

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Yields and Root Rot Tolerance in Strains of Empire and European Types of Birdsfoot Trefoil

Stanley A. Ostazeski, Paul R. Henson, and Lester A. Tayman (Beltsville)

Varieties of birdsfoot trefoil are not long lived near Beltsville, Md., due to the root rot disease(s) prevalent in the area. In early spring-seeded stands, first- and second-cutting hay yields in the second year are generally good. Recovery growth may be too poor to allow for a third cutting. In general, European types appear to be more root rot tolerant than Empire types. The data presented herein indicate that there are different levels of root rot tolerance within both types, and these differences can be exploited.

We designed experiments to compare the performance of (1) Empire and seven Empire-derived varieties and strains and (2) in the same area, an experimental synthetic and two standard varieties of European origin. Six to eight 10-plant replications were used to evaluate Empire types, and six 20-plant replications were used to evaluate strains of European origin. Vigor notes, yields, and root rot ratings were taken periodically. The varieties evaluated and the data obtained are summarized in Tables 1 and 2.

A comparison of losses of the same varieties in the summers of 1967 and 1968 used in other experiments suggests that 1968 was a "severe root rot year." The major difference between the two years was the general lack of rainfall and a cool daily temperature in the summer of 1967. The summer of 1968 was unusually hot with above-average rainfall during the rating period. Through the years we have observed that plant losses in 2-year-old stands tend to be greater in wet, warm summers.

Varieties such as Dawn, field selected for persistence in an area where root rots are a problem, are vastly superior to Empire (Table 1) or synthetics, such as SES1, developed where root rots are not a factor. Performance data of 91 Mod and Dawn in Table 1 indicate that resistance is heritable. Plants in 91 Mod are the progeny of a single cross of select clones from the strain from which Dawn was derived.

Two complete replications of the European strains were rated for root rot on each of three dates during the 1968 growing season (7/11, 8/14, 9/5). Results recorded in Table 2 show how the disease increases in prevalence and severity during the season. This is indicated by an increase in the "root rot rating" and a marked drop in "% rating 1-3." These data support our belief that the root rot problem is aggravated in producing stands by extended periods of very warm weather.

The level of tolerance developed in Md-1 (Table 2) shows greater promise of root rot tolerance in the European than in the Empire types. However, 2-year cycles with a high percentage of escapes have tended to dilute our efforts to date in developing root rot tolerance in both types. What is needed at present is a critical, short-term test for isolating root rot tolerance. We hope to be able to report favorably on this aspect of the problem in the near future.

Table 1. Performance of Empire birdsfoot trefoil and strains of Empire origin, 1967-68, Beltsville, Maryland.

Variety	No. of plants	Avg. vigor[1] 9/21/67	Avg. green yields in gms/plant on: 5/20/68	7/1/68	Avg.[6] root rot 7/24/68	% plants with 1-3 root rot rating
Empire	76	4.77ab*	69ab	52 bcd	8.19 b	3.9
NK-6-128	77	5.03a	66abc	66 bc	8.73 b	0.0
Ia-3020	52	4.30 bc	52 bc	51 cd	7.74 b	5.8
Dawn	73	5.10a	86a	77ab	7.43ab	11.0
Minn.[2]	69	5.04a	59 bc	59 bcd	8.37 b	7.2
8ESV [3]	57	4.77ab	41 c	34 d	8.71 b	0.0
91 Mo-1[4]	63	4.17 c	87a	95a	6.40a	27.0
95 Mo-1[5]	75	3.66 d	67ab	67abc	7.96 b	7.9

* Ratings with different letters are significantly different at the 5% level using the Duncan Multiple Range Test.

1/ Average vigor based on 9 = excellent vigor, 1 = poor vigor.

2/ Seed stock collected in Minnesota by C. H. Hanson.

3/ Seed stock selected for seedling vigor only, in the greenhouse.

4/ Single cross of two 3-year-old Mo-1 plants Beltsville.

5/ Intercross of 6 S_1 plants of 91 and 8 other select Mo-1 plants.

6/ Root rot based on 1 = disease free, 9 = dead.

Table 2. Performance of an experimental bird-foot trefoil synthetic (European type) compared with 2 varieties.

Variety	Avg. vigor	Avg. green yields in gms/plant on 5/7/68	6/17/68	Root rot rating on: 7/11 Avg.	% rating 1-3	8/14 Avg.	% rating 1-3	9/5 Avg.	% rating 1-3
Viking	4.7	126	137	7.2	15.0	8.7	2 6	8.9	0.0
Cascade	4.7	136	150	7.6	10 3	9.0	0.0	9.0	0.0
Md.-1	5.7	136	155	2.4	87.5	7 0	17.5	7.9	5.1

* * *

MICHIGAN

Further Studies on Selected Varieties and Hybrids of Three Annual Legumes for Use in Northern Michigan

H. L. Kohls, F. C. Elliott, and J. S. Shenk (Lansing)

Four varieties of common vetch, Vicia sativa, and several varieties of Lupinus angustifolius and L. albus were chosen for further study because of their superior yields of seed and forage. Seed increases of these species were grown in 1967, and bioassays were made a little later on each variety. Yields are shown in Tables 1 and 2.

M.S.U. 59-224, a common vetch, gave the highest forage yield for the 3-year period, but it was the lowest in seed yield. P.I. 220,906 produced 3,484 pounds of forage but gave an excellent yield of seed--1,029 pounds per acre. M.S.U. 59-208 was not the highest yielding but gave relatively good yields of both forage and seed.

Yields of forage and grain of four varieties of blue lupines and three white lupines are shown in Table 2. The blue varieties produced more forage and less seed than most of the white varieties. It appears from our present data that high yields of forage and seed can be produced from selected varieties of V. sativa, L. angustifolius, and L. albus

Preliminary trials have been made on selected varieties and hybrids in these species to obtain some information on their probable feeding value One trial was with vetch seed using voles as the bioassay animals (see Table 3). Their response was not good. Only two animals lived the full seven days of the trial. It appeared that all the vetch varieties contained a substance harmful to the voles, but some varieties contained less of the harmful material than other varieties

Voles responded more favorably to seed of lupines than to vetch (see Table 4). The animals lived the full seven days, gain in weight was positive in all cases, and efficiency in some cases was good. Gain and efficiency in two varieties was about double that of the other varieties, which indicates the possibility of selecting varieties of blue lupines with relatively high feeding value.

The unsuccessful attempt to prevent loss of weight and death of animals when a vetch diet was modified with vitamins and alfalfa hay is shown in Table 5. But when tall fescue hay and vetch seed were fed free choice to young guinea pigs (Table 6), the response was good. Their ration was 76.4% vetch and 23.6% tall fescue hay, and the efficiency factor was 25.5. This efficiency factor compares favorably with the lupine and soybean diets shown in the same table and is twice the size of 11.6 for alfalfa fed without grain.

Conclusions and recommendations cannot be made at this time, but work on these legume crops is being continued

Table 1. Seed and forage yields, in pounds per acre, of common vetch grown at Lake City and calculated at 12 percent moisture.

M.S.U. or P.I. Number	1961			1962			1963			1964		
	Forage	Seed	Total	Forage	Seed	Total	Forage	Seed	Total	Forage	Seed	Total
P.I. 220,893	5,728	985	6,713	4,278	612	4,890	2,632	313	2,944	4,213	636	4,849
P.I. 220,906	4,270	1,457	5,727	3,576	1,172	4,748	2,606	459	3,065	3,484	1,029	4,513
M.S.U. 59-208	5,067	1,142	6,209	4,921	949	5,870	3,033	349	3,382	4,340	813	5,153
M.S.U. 59-224	5,315	481	5,197	5,197	478	5,675	3,277	280	3,557	4,596	413	5,009

Table 2. Forage and seed yields per acre of two species of lupines at Lake City, calculated at 12 percent moisture.

Variety and species	1961 Seed	1962* Forage	1962* Seed	Average Seed
L. angustifolius, Bitter	1,720	4,467	894	1,307
L. angustifolius, Blanco	893	5,157	433	663
L. angustifolius, Borre	1,445	5,179	812	1,129
L. angustifolius, P.I. 237,721	1,534	5,628	1,430	1,482
L. albus, M.S.U. Composite	1,655	4,058	1,727	1,691
L. albus, U.S.S.R. 305	1,728	3,924	1,618	1,673
L. albus, P.I. 243,335	1,595	3,067	1,479	1,537

* Yields of forage were taken just before leaves began to fall. Forage and seed yields were from two separate but adjacent fields.

Table 3. Response of voles fed four varieties of common vetch seed in a diet of one-half vetch, one-half alphacel, and 3 grams of mineral mix. The gain in body and food consumed are shown in grams for the period of time the animals lived in the trial.

Vetch varieties	Gain[a]	Consumption	Days Alive
P.I. 220,893	- 2.0	2.0	2
	- 2.0	4.0	3
	- 1.5	7.0	3
	0.0	19.5	5
P.I. 220,906	- 0.5	26.5	7 b
	- 0.5	26.5	7 b
	- 0.5	12.0	4
	1.5	14.5	4
M.S.U. 59-208	- 1.0	12.5	5
	- 1.0	12.5	5
	1.0	13.0	4
	- 0.5	13.0	4
M.S.U. 59-224	- 1.5	10.5	4
	- 1.5	10.5	3
	1.0	20.0	5
	- 1.0	5.0	3

(a) The first two voles on each diet were litter mates.

(b) Both animals were alive when experiment ended.

Table 4. Response of voles fed seed of six lines of sweet blue lupines.

Lupine Variety in Diet**	Gain*	Efficiency
	(gms)	
Rancher	3.0	10.1
237,721 X S-13 (blue flower)	3.5	9.9
237,721 X Borre (blue flower)	3.0	8.1
237,721 X Borre (pink flower)	6.0	18.9
Blanco X Bitter (dark seed)	6.3	16.8
Blanco X Bitter (white seed)	3.0	8.5
Synthetic control	5.0	16.7

* Gain in weight in grams, average of 2 voles.

** Diet consisted of one-half lupine seed, one-half alphacel, plus three grams of mineral mix.

Table 5. Diet changes made in an attempt to prevent death of voles.

Diet*	Gain	Consumption	Days Alive
P.I. 220,893 seed + vitamins	-1.5	14.5	5
P.I. 220.893 seed boiled and vitamins added	-2.0	18.5	5
P.I. 220,893 seed, vitamins added + 10% alfalfa	-1.0	13.5	5

* Basic diet same as in Table 2 but with changes noted in this table.

Table 6. Response of guinea pigs when given free choice of hay and grain. Four animals were used on each diet except as noted below.

	Efficiency	Percent grain
Tall fescue* and vetch grain	25.5	76.4
Tall fescue* and sweet blue lupine	27.2	75.2
Tall fescue* and soybean meal**	30.9	83.5
Alfalfa* and sweet blue lupine seed	27.5	85.2
Alfalfa* and soybean meal	28.2	92.4
Alfalfa* and no grain***	11.6	--

* First cutting.

** Average of 3 animals.

*** Average of 2 animals.

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MINNESOTA

Establishment of Birdsfoot Trefoil Variety Trials

H. L. Thomas and D. M. Smith (St. Paul)

A birdsfoot trefoil, Lotus corniculatus L., variety trial was established at the University of Minnesota's Rosemount Station during the spring of 1967. Ten entries with four replications were seeded on May 8, 1967, in soil which had been treated with 3 pounds of EPTC incorporated. Weed control was very good.

On August 3 a forage harvest was taken. This was a remarkable yield for the seedling year.

The following table reports data from this harvest during the seedling year and data collected following the first over wintering.

Variety	Yield in T/A 15% moisture 8/3/67	Test of significance*	% Dry matter	% Bloom 8/3/67	Recovery after cutting** 8/25/67	Vigor** 7/11/67	Vigor*** 4/26/68	% Dead 4/26/68
Mo-10	1.48	a	22.5	83	2.0	5.5	4.5	80
MC-H	1.38	ab	23.3	63	2.5	4.3	2.0	3
R1 (Iowa)	1.36	ab	23.5	70	2.5	5.0	2.0	3
Leo	1.31	ab	22.4	73	3.5	5.8	1.0	1
Mansfield	1.23	ab	23.5	35	2.0	6.0	5.0	95
Mo-110	1.18	abc	23.0	68	1.0	5.5	5.0	80
E1 (Iowa)	1.09	bc	23.6	58	4.5	6.0	4.5	60
Dawn	1.09	bc	24.2	30	3.0	7.0	3.5	21
Viking	.88	cd	23.5	43	2.0	5.5	3.0	50
Empire	.59	d	23.2	23	3.5	7.0	4.0	30

* Varieties with a common letter are not significantly different.

** Height: 9 = 0-2 in., 8 = 2-4 in., 7 = 4-6 in., 6 = 6-8 in., 5 = 8-10 in., 4 = 10-12 in.

*** Score 1-5: 1 = most vigorous of surviving plants.

MISSOURI

Controlling Weeds in Seedling Crownvetch

E. J. Peters (Columbia)

Preplant applications of 3 lb/A of EPTC, 1 to 1½ lb/A of benefin, and 1/2 to 1 lb/A of trifluralin controlled weed grasses and many broadleaved weeds in crownvetch (Coronilla varia). The crownvetch was planted in early April, immediately after the herbicides were applied and lightly disked and harrowed into the soil. No injury to crownvetch was apparent. Benefin and trifluralin failed to control ragweeds, but mowing was effective for controlling broadleaved weeds that were not controlled with herbicides. Benefin was somewhat more consistent and controlled weed grasses longer than did EPTC. Three to 5 pounds per acre of dalapon applied either preemergence or postemergence controlled weed grasses for a limited time.

Bromoxynil and 2,4-DB both injured crownvetch and were not suitable for postemergence applications.

Publications:

Peters, E. J. and J. F. Stritzke. Pre- and post-emergence herbicides for control of weeds in crownvetch (Coronilla varia L.). NCWCC Res. Rpt., p 68-69, 1966.

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MONTANA

Sainfoin Hay Yields in Montana

A. E. Carleton and C. S. Cooper (Bozeman)

Sainfoin (Onobrychis viciaefolia) is rapidly acquiring economic importance in Montana. There is currently some 7 to 8 thousand acres in production, and 137,000 pounds of certified seed of the variety Eski was produced in 1967. Sainfoin has been under test in Montana since 1954; however, there are still many aspects of sainfoin production that have not been thoroughly investigated. This report gives the summary of several hay trials in which the variety Eski has been compared to alfalfa.

The hay yields of alfalfa and sainfoin on dryland are given in Table 1 and on irrigated land in Table 2. In each trial, Eski has been compared to the recommended alfalfa variety for the area which was either Vernal or Ladak. Alfalfa plots in areas of heavy alfalfa weevil infestation were treated to prevent loss of yields, and thus all trials are comparisons of Eski with non-weevil-damaged alfalfa.

Tables 1 and 2 show considerable variability in the performance of both Eski and alfalfa within locations. However, when all trials are considered, alfalfa produced about 1/3 of a ton more hay on both dryland and irrigated land than Eski. The growth patterns for Eski and alfalfa are quite different. Eski produces approximately 3/4 of its total season yield in the first cutting. Even the alfalfa variety Ladak does not have this dependence upon first cutting yield. Therefore, a large portion of variability in the comparison of hay yields of Eski and alfalfa can be explained by the interactions of growing season and species growth patterns.

Sainfoin has two important economic traits not presently available in alfalfa. Sainfoin is not known to cause bloat and is resistant to the alfalfa weevil. These factors, along with good hay yields in many instances, have led to the release and recommendation of Eski sainfoin in Montana.

It is hoped that current investigations will better delineate those areas in which sainfoin can compete favorably as a crop with alfalfa. Plant materials are available for increasing second and third cutting yields of sainfoin to more nearly equal those of alfalfa.

Table 1. Dryland hay yields of Eski sainfoin when compared to alfalfa at three locations in Montana.

Location	Trial #	Year of Test	Yield in T/A at 12% H_2O	
			Alfalfa	Sainfoin
Moccasin	1	1961	65	.59
	2	1964	2.57	1.53
		1965	2.04	.60
	3	1966	.77	.93
		1967	1.90	1.74
	4	1967	2.03	2.94
	5	1967	2.94	2.16
Creston	1	1961	3.55	4.54
		1962	3.56	3.41
		1963	1.97	2.87
	2	1964	3.46	3.43
		1965	1.77	3.12
Lincoln	1	1964	1.28	.32
		1965	2.84	1.07
		1966	3.55	1.24
	all trials		2.31	2.03

Table 2. Irrigated hay yields of Eski sainfoin when compared to alfalfa at eight locations in Montana.

Location	Trial #	Year of Test	Yield in T/A at 12% H_2O	
			Alfalfa	Sainfoin
Bozeman	1	1961	4.84	4.42
		1962	4.24	4.25
		1963	2.81	1.97
	2	1966	4.31	5.09
		1967	6.76	6.50
	3	1966	5.10	5.72
		1967	5.55	5.10
Creston	1	1961	5.17	4.22
		1962	2.05	2.25
		1963	2.00	2.38
	2	1965	2.90	2.94
		1966	4.08	3.61
		1967	3.67	3.01
	3	1966	4.64	6.39
	4	1966	1.46	1.35
		1967	5.98	4.60
	5	1966	4.89	5.57
		1967	5.52	3.75
Flathead (Co.)	1	1964	5.40	4.24
		1965	4.21	5.21
		1966	3.61	3.41
Ravalli (Co.)	1	1964	5.97	4.17
		1965	3.47	2.49
		1966	4.74	3.36
Huntley	1	1966	4.05	7.77
		1967	11.38	8.95
Ronan	1	1967	3.28	2.31
Missoula (Co.)	1	1967	7.28	5.39
	all trial $\bar{x}$		4.62	4.30

Publications:

Carleton, A. E., C. S. Cooper, and L. E. Wiesner. 1968. Effects of seed pod and temperature on speed of germination and seedling elongation of sainfoin. Agron. J. 60:81-84.

Eslick, R. F., A. E. Carleton, and G. P. Hartman. 1967. Registration of Eski sainfoin. Crop Sci. 7:402-403.

Cooper, C. S. and C. W. Roath. 1965. Sainfoin for hay in Montana. Mont. Agr. Expt. Sta. Quart. "NOW" 1.3-5.

Eslick, R. F. 1965. Trials with sainfoin. Mont. Agr. Expt. Sta. Quart. "NOW" 1:6-7.

Cooper, C. S. and C. A. Watson. 1968. Total available carbohydrates in roots of sainfoin (Onobrychis viciaefolia Scop.) and alfalfa (Medicago sativa L.) when grown under several management regimes. Crop Sci. 8:83-85.

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NORTH CAROLINA

Animal Performance on Crownvetch in North Carolina

J. C. Burns, W. A. Cope, L. Goode, R. W. Harvey, and H. D. Gross (Raleigh)

Two plantings of crownvetch were grazed in 1966 and 1967--a 5-acre planting on a typical Piedmont soil and a 5-acre crownvetch-native grass mixture in the mountains at an elevation near 3,000 feet. Both areas received recommended pasture fertilization. In 1966 growth was accumulated at each location and utilized as needed, and in 1967 each area was grazed for extended periods. Rainfall distribution for each location is shown in Table 1.

On the Piedmont planting in 1966 grazing was started on May 10 with a heavy growth in full bloom. Animals were slow to accept crownvetch at first but grazed well after a few days. Five of ten steers grazed 35 days with an average daily gain of 0.4 pound, and the other five grazed 70 days for an ADG of 0.76 pound (Table 2). At the mountain planting in 1966 the Experiment Station cow-calf herd readily grazed the mature growth with a heavy green seed crop, beginning in mid-August. At both locations the heavy growth was well utilized with the exception of large stems and a small amount that was trampled.

At the Piedmont Station in 1967 grazing was maintained over most of the season, using 2-year-old steers (Table 3). We were successful in maintaining a satisfactory stocking rate, and the growth was kept at approximately 2 to 6 inches until late in the grazing season (September). Three steers made an ADG of 1.3 pounds with a final average animal weight of over 1,100 pounds. Two steers grazed 154 days each, and one grazed for 134 days.

At the Mountain Station in 1967 three cow-calf units were used to graze the crownvetch pasture beginning the last of June (Table 4). The pasture had been clipped high earlier to remove excess growth. Grazing continued for a 70-day period. Calves gained 2 pounds a day for the period, similar to performance on other pastures in the test, and the dams gained almost 1 pound a day.

Results from our studies in North Carolina indicate that we should be able to utilize crownvetch as a pasture plant during the entire growing season under continuous grazing or for accumulating growth and using it as needed. The latter method could be valuable for the "summer slump" period of low forage production. To date there is no evidence of serious stand losses in the grazed areas. There may be some problem with animal acceptance of crownvetch under certain undefined environmental conditions. However, based on the limited data presented in this report, animal performance on crownvetch appears acceptable.

Table 1. Summary of rainfall distribution for the Piedmont and Mountain Research Stations, Rowan County, and Laurel Springs, respectively, 1966-1967.

Station	Rainfall, inches per month*						
	March	April	May	June	July	Aug.	Sept.
Piedmont							
1966	2.0	1.6	2.4	2.4	2.8	3.7	3.5
1967	2.0	3.7	4.5	1.3	3.1	6.0	3.4
Mountain							
1966	1.3	4.6	4.5	3.8	4.7	5.0	8.2
1967	4.1	2.6	4.4	2.2	7.8	6.6	4.7

* Deficits in inches for the 5-month period (March-July) was -9.2, 1966, and -7.3, 1967, at the Piedmont Station, and -4.02, 1966, and -1.77, 1967, at the Mountain Station.

Table 2. Summary of the performance* of two groups** of steers grazed on crownvetch, Piedmont Research Station, Rowan County, 1966.

Group of steers	Initial wt. (5/10/66)	Lb. gain	Days grazed	ADG
1	673	14	35	0.40
2	659	53	70	0.76

* All values are the means of 5 steers.

** Group 1 grazed from 5/10 to 6/14; Group 2 grazed from 5/10 to 7/19.

Table 3. Summary of steer performance and grazing periods, Piedmont Research Station, 1967.

Animal* no.	Initial wt. (4/20/67)	Lb. gain	Days grazed	ADG
53	950	195	154	1.27
15	995	195	154	1.27
72	890	175	134	1.31

* All animals grazed 4/20 to 5/12. Animals 53 and 72 grazed 5/19 to 9/28. Animal 72 grazed 5/19 to 8/9 and 8/29 to 9/28.

Table 4. Summary of cow and calf performance* on a crownvetch-grass mixture** after June 28, Mountain Research Station, Laurel Springs, 1967.

	Two-week weight periods				
	7/12	7/26	8/9	8/23	9/6
Calf ADG					
by period	2.0	2.0	1.2	2.0	3.0
accumulative	2.0	2.0	1.7	1.8	2.0
Cow ADG					
by period	0.9	0.?	-0.9	0.7	3.4
accumulative	0.9	0.5	0.1	0.2	0.9

* All values are the means of three cows and their calves.

** Mixture consisted of approximately 50% crownvetch and 50% bluegrass and quackgrass (visual observations).

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OHIO

Birdsfoot Trefoil and Crownvetch Studies

R. W. Van Keuren (Wooster)

Birdsfoot trefoil and crownvetch are being studied under several projects in Ohio. Birdsfoot trefoil is well adapted in northern Ohio. It has received extensive study in Ohio, particularly as a permanent pasture legume. Trefoil tends to be short-lived in southern Ohio, and crownvetch is being studied as a possible long-lived permanent pasture legume for southeastern and southern Ohio.

Effect of companion grazing and stocking pressure on plant and animal response, Hatch 283.

Empire birdsfoot trefoil and Kentucky bluegrass are being used in the pasture mixture to study the effect of grazing sheep and cattle together at several sheep/cattle ratios on the total animal product per acre, animal gain, and trefoil persistence. There appears to be an advantage in adding sheep to a pasture being grazed by cattle but not to adding cattle to sheep. Sheep alone appear to more completely utilize a pasture than do cattle alone. After three years, there appears to be no difference in trefoil persistence between treatments.

Sheep are also grazing trefoil-bluegrass at five stocking rates. The heaviest stocking rate is reducing the trefoil stand compared with the lighter stocking rates and is resulting in increased weed encroachment. All pastures are being grazed rotationally.

Trefoil and crownvetch varietal trials, State 353

Seven birdsfoot trefoil and four crownvetch varieties were established in April 1967 in new variety trials. A crownvetch variety trial established in April 1963 is being continued. In the latter trial, Chemung, Emerald, and Penngift yield similarly under a 2-cut hay schedule.

Interrelationships of forages and beef cow and calf production under southern Ohio conditions, Hatch 271

The results obtained to date with crownvetch under grazing are summarized in reports listed in the publications below (see 2 and 4). New seedings of Emerald and Chemung crownvetch for pasture are being established in southeastern Ohio in 1968.

Publications:

Van Keuren, R. S., C. H. Parker, and E. W. Klostermar. 1967. Effect of companion grazing and stocking pressure on plant and animal response (Empire birdsfoot trefoil-Kentucky bluegrass mixture). Agron. Abstr.

Van Keuren, R. W. 1968 Crownvetch for forage. Ohio Report 53(1): 12-14.

Van Keuren, R. W. and R. R. Davis. 1968. Persistence of birdsfoot trefoil, Lotus corniculatus L., as influenced by plant growth habit and grazing management Agron. J. 60:92-95.

Van Keuren, R. W. 1968. Crownvetch research in Ohio. Proc. 2nd Crownvetch Symposium, Pennsylvania State University, Feb. 29-March 1, 1968.

OREGON

Big Trefoil Strain Trial

S. L. Swanson and Wm. H. Billings (Corvallis)

To compare yields, persistence, and growth characteristics of six Lotus uliginosus accessions, a replicated and randomized trial was initiated in the spring of 1963. Consistently the highest yielding accession, P-15553 (P.I. 48,636), persisted as well as Columbia and Beaver. Commercial and Border were intermediate in numbers of plants lost, and P-15050 suffered by far the greatest loss of plants. The trial was not irrigated, and the soil is deep and well drained.

Based on four years of data from this trial, as well as the results of other tests conducted at Corvallis, P-15553 is now being tested in field plantings in Soil and Water Conservation Districts in western Oregon and western Washington. It is being compared to commercial big trefoil in pasture mixtures on tidelands and other low, wet areas. Where annual precipitation averages 60 inches or more, it is scheduled for testing in pasture plantings on upland sites; and for erosion control on logged and burned-over timberland, on newly constructed power line rights-of-way, and on road cuts and fills. Its usefulness as feed for Coastal elk, as well as for beautification, will also be evaluated.

H. H. Rampton, ARS, provided the seed used for establishment of the seed increase field at Corvallis PMC. This accession is erect, medium in height, uniform, intermediate in reaching maturity, and predominantly glabrous. In color, P-15553 has a blue-green appearance, apparently due to varying degrees of red or stem and leaves.

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Trefoil Seed Production Progress

S. L. Swanson (Corvallis)

Three trefoils being increased by the Corvallis Plant Materials Center for final testing in field plantings yielded exceptionally well in 1967. Cascade broad-leaf and Los Banos narrow-leaf each produced 300 lb/A, and big trefoil P-15553 (P.I. 48,636) produced 640 lb/A of clean seed. Substantially greater than ever before obtained at the Center, these high yields are attributed to several factors, including adequate fertilization and irrigation, fungus and insect control, timely harvesting, and use of small asphalt laminated burlap "tarps" in the field to minimize shattering loss. Estimating conservatively, the "tarps" reduced seed shattering losses of big trefoil at least 25% and of the Cascade and Los Banos trefoils at least 35%.

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SOUTH CAROLINA

Breeding and Genetics, Diseases, Quality and Varietal Evaluation, and Culture and Physiology of Perennial Species of Clovers for Hay, Pasture, Seed, and Soil Improvement

Pryce B. Gibson (Clemson)

Species hybrids. Research involving species hybrids is being concentrated around the three crosses involving Trifolium nigrescens Viv., T. occidentale D. Coombe, and T. repens L. The difficulty of obtaining the hybrids varies with ploidy levels and is indicated below as:

Ex. D = extremely difficult, many crosses 1,000 or more were made to obtain a seed.
Diff. = difficult, 100 or so crosses made to obtain a seed.
Rel E. = relatively easy, a seed or more obtained for every 10 or so florets pollinated

	Cross and Somatic Chromosome Complement					Difficulty of making cross
1a	T. nigrescens	(2n=16)	x	T. occidentale	(2n=16)	Ex. D.
2a	" "	"	x	" "	(2n=32)	Rel. E.
3a	" "	(2n=32)	x	" "	"	Diff.*

* Only triploids obtained from this cross. Plants appear to be same as those from cross 2a.

1b	T. repens	(2n=32)	x	T. occidentale	(2n=16)	Ex. D.
2b	" "	"	x	" "	(2n=32)	Rel. E.
3b	" "	(2n=48)	x	" "	"	Rel. E.
4b	" "	(2n=64)	x	" "	"	Rel. E.

1c	T. repens	(2n=32)	x	T. nigrescens	(2n=16)	Rel. E.
2c	" "	(2n=64)	x	" "	(2n=32)	Rel. E.

Since different numbers of pollinations and pollinations made at different times are involved these ratings should be considered preliminary estimates only. Also, the number of pollinations required to obtain a hybrid varies among plants of a species. In most crosses, by carefully selecting the specific parent plants used, the number of pollinations required to obtain a hybrid can be substantially changed.

The most promising hybrid plants were obtained from cross 4b. The 2n=48 plants are leafy, vigorous, stoloniferous and branch profusely.

The results of cross 3a are not understood. Apparently some mechanism favors the development of the triploid over the development of the allotetraploid. The seed parents used were treated with colchicine in the seedling stage and therefore could have had diploid sectors. The cross is being repeated using second generation tetraploid plants to reduce the possibility of chimeras.

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TEXAS

Contribution from Rice-Pasture Research and Extension Center
Texas A&M University, Beaumont, Texas

R. H. Brown and J. P. Craigmiles (Beaumont)

Clovers grow vigorously in the Beaumont area with its high annual rainfall of 56 inches. White clover, Persian clover, and Bur clover predominate naturally. Berseem, T. michelianum, T. vesiculosum and Ball clover show promise.

La S-1 white clover is the most widely grown variety, although recently much interest has been shown in Regal and Tillman. To obtain information on the relative value of the clovers, a white clover variety trial was seeded each year from 1963 to 1966 on a well-prepared seed bed with 60 pounds of P_2O_5 per acre applied annually. Varieties tested were not the same each year, but certain varieties were included each year: Espanso, La S-1, Nolin's Improved, and Regal. Older seedings yielded less in 1967 than those seeded in 1965 and 1966; however, yields were not statistically different among varieties for seedings made in 1963, 1964, and 1965. Yields for varieties seeded in 1966 ranged from 3,891 pounds per acre for N6-521 (low germination) to 5,706 pounds per acre for Regal. All varieties persisted and produced forage throughout the summer because of ample moisture.

Three years' results have also been obtained from a compatability clipping study of oats, ryegrass, and clovers. Four clovers--Berseem, Ball, Michelianum, and Abon Persian--were seeded in October alone, with Gulf ryegrass, with Moregrain oats, or in mixtures with the two.

Mixtures giving highest total yields (5,800 to 6,100 pounds) were oats-Abon clover and oats-michelianum clover. The lowest yielding group (3,400 to 4,000 pounds per acre) included Berseem, Ball, Michelianum, with ryegrass and oats. In the January 6 clipping the pure clover stands produced the least forage and the oats, ryegrass, and clover mixtures yielded the most. The most productive plots at the last harvest on May 8 contained Abon clover. Berseem clover was damaged by cold twice during the winter.

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VIRGINIA

Method of Planting Study with Birdsfoot Trefoil

John D. Miller (Blacksburg)

Five trefoil varieties were grown in broadcast plots, drilled rows, and as plants spaced 6 inches apart in rows for the period 1965-67. Data were obtained on forage yield, vigor, plant growth, type, flowering date, and percent stand

Two harvests were made in each of two years. Variety differences were significant in all cases. Differences among planting methods were significant at only one harvest. This difference may have been due to a very dry period in June 1966. A variety x method interaction existed only for the harvest where methods were significantly different. Varieties ranked similarly for all three methods in mos cases. Yields for all three methods were strongly correlated except for the harvest where methods were significantly different.

Initially, stands were not correlated for the three methods, but at the end of three seasons they were correlated at the 1% level. Yields and stands were also highly correlated in most instances. Varietal differences were significant with Granger, Viking, and Virginia Synthetic Number One about equal. Empire was lower than these three varieties but better than Vega, which is non-hardy. When data for initial and final stands were combined, significant differences were found for methods, varieties, years, years x varieties, and years x varieties x methods. Spaced plants survived best with drilled rows second and broadcast plots poorest.

Differences between varieties for flowering date were highly significant with Vega earliest and Empire latest. Methods were very similar with highly significant correlations ranging from +.858 to +.898.

Vigor differences were highly significant for varieties on one date but not on another. Highly significant differences existed between methods in the fall of the establishment year. Correlations among methods were not significant for either date.

For growth type, varietal differences were highly significant. Varieties fell into three classes. Vega was most erect; Granger, Viking, and Virginia Synthetic Number One were semi-erect, and Empire was decumbent. Methods of planting were significantly different with plants in broadcast plots being more erect and spaced plants more decumbent Drilled rows were intermediate and not statistically different from the other two methods. These differences may have resulted in part from notes being taken late in the year, since spaced trefoil plants tend to become more decumbent as fall approaches.

Usually it is desirable to evaluate strains for a number of characters which vary in importance. For trefoil, forage yield is undoubtedly of more importance than any other characteristic. Similarity among methods of planting for yield was indicated by analysis of variance and correlation coefficients for most harvests. Some other characters were similar for all methods of planting, while certain others were not. All in all, the results indicate that any of the three methods would be satisfactory. In cases where seed is scarce, drilled rows or spaced plants could be used instead of broadcast plots. More strains could be evaluated in the same area at a lower cost using spaced plants or drilled rows.

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WISCONSIN

Legume Species and Variety Trials
Arlington, Wisconsin, 1967

J. M. Scholl (Madison)

The legumes in Tables 1 and 2 were seeded in 1966 in plots 6 x 20 ft with three replications mainly for observational purposes. Yields were determined by two hay harvests in 1967. Subsequently they will be harvested three or four times per season.

The two trials were seeded at the same time and harvested on the same dates.

Table 1. Ladino and White Clover.

Variety	Yield D.M. (tons per acre) 1/		
	July 5	Aug. 31	Total
Ladino			
Merit	1.71	.39	2.10
Regal	1.54	.46	2.00
Cranladino	1.53	.38	1.91
Ore. Cert. Ladino	1.50	.37	1.87
White Clover			
Common white	1.50	28	1.78
C.V. 17%			N.S.

1/ Seeded May 3, 1966. Parr silt loam.

Table 2. Birdsfoot trefoil and crownvetch.

Variety	Yield D.M. (tons per acre) 1/		
	July 5	Aug. 31	Total
Birdsfoot trefoil			
Empire	1.87	.56	2.43
Fargo	1.86	.52	2.38
Viking	1.61	.68	2.29
Crownvetch			
Emerald	2.13	.61	2.74
C.V. 21%			N.S.

1/ Seeded May 3, 1966. Parr silt loam.

Table 3. Yield of dry matter from three grazing type alfalfas grown alone or in alternate rows with alfalfa and harvested either three times for hay or four times for pasture. Arlington, Wisconsin, 1967.

Varieties	Pasture Management 2/		Hay Management 2/	
	Legumes alone	Mixtures	Legumes alone	Mixtures
	tons/A 1/			
Alfalfa				
Vernal	3.83	2.95	4.14	3.64
Teton	3.08	2.67	3.76	3.56
Travois	2.90	2.31	3.49	3.27
Birdsfoot trefoil				
Empire	2.01	1.85	3.11	2.40

1/ Seeded May 3, 1966, in 7-inch drill rows either alone or in alternate rows with Sac bromegrass. Parr silt loam.

2/ Harvest dates: Hay management--June 12, July 25, August 31.
Pasture management--June 2, July 1, Aug. 15, Sept. 12

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Genetics and Breeding of Red Clover

R. R. Smith (Madison)

Breeding for persistence and disease resistance. In Wisconsin, as in much of the north-central region, a desirable prerequisite for a good variety of red clover is the ability to persist into the second harvest year. Consequently, one of the primary objectives of the red clover breeding program has been to investigate the potential for improvement in persistence. Coupled with this objective has been the desire to improve the resistance to various economically destructive disease pathogens. From the efforts of O. F. Smith, J. L. Allison, J. H. Torrie, E. W. Hanson, and W. K. Smith there arose a continuing selection program for persistency and disease resistance which eventually led to the release of the cultivar, Lakeland. This program remains active and, at the present time, selection is being carried on independently in populations from numerous different sources. These populations are in their first or second cycle of selection for persistency. Recent tests using synthetics derived from these sources suggest that improvement in persistency and disease resistance has been obtained. Long term average forage yields for some strains of medium red clover tested in Wisconsin are presented in Table 1. During the 1967 growing season some breeding lines were subjected to artificial epiphytotics of powdery mildew, northern anthracnose, and a complex of viruses (primarily bean yellow mosaic virus). Susceptible plants were removed and the survivors will be transplanted to a controlled pollination area in 1968.

Genetic studies. Two quantitative genetic studies have been initiated. One study will investigate the quantitative inheritance of seed yield components. The second study will attempt to estimate the type of gene actions operative and of most importance in the cultivar, Lakeland, for characters other than seed yield. Plant material will be evaluated in the nursery in 1968. Studies were initiated to investigate the inheritance of several genetic characters. A 1 1 ratio of male fertile to male sterile plants was observed in F_1 progeny of a cross involving male fertile and male sterile plants. The sib-mated F_2 and backcross progeny are presently being classified. A population containing only three sterility (S) alleles and the marker gene for white flower color was developed, preparatory to S allele mutation studies. This population is in the third generation of synthesis with no new sterility alleles apparent. Studies investigating the inheritance of leaf markings of red clover have been continued.

Table 1. Long term[a] average forage yields[b] for strains of medium red clover evaluated in Wisconsin.

Variety or strain	Madison		Hancock		Marsh-field		Spooner		Ashland		Mean		
	1st year	2nd year	1st year	2nd year	1st year	2nd[c] year	1st year	2nd year	1st year	2nd year	1st year	2nd year	%[d]
Lakeland	3.7	2.2	1.8	1.2	3.4	2.7	3.0	1.8	2.8	2.2	2.9	2.0	69
Dollard	3.5	2.1	1.9	1.0	3.4	2.9	2.8	1.8	2.8	2.2	2.9	2.0	69
LaSalle	3.4	1.7	1.8	1.0	3.3	2.7	3.0	1.8	2.8	2.2	2.9	1.9	65
Kenland	3.4	1.3	1.7	1.0	3.0	1.9	3.0	1.6	2.6	1.4	2.7	1.4	51
Common	3.5	1.3	1.8	1.0	3.0	1.9	2.9	1.6	2.6	1.6	2.7	1.5	56
Mean	3.5	1.7	1.8	1.0	3.2	2.4	2.9	1.7	2.7	1.9	2.8	1.8	64
	(48%)[d]		(56%)		(75%)		(59%)		(70%)			(64%)	
Wisconsin Synthetics[e]													
61 Surv.											3.1	2.4	
61 W											3.0	2.1	
Syn B											3.1	-	
Syn C											3.8	2.7	
Syn D											3.8	2.6	
Mean											3.6	2.4	67

a/ Averages per location and variety are based on data from 1957 to 1966. Not all location or varieties cover this period inclusive.

b/ T/A of dry matter.

c/ Two-year averages.

d/ Percent second harvest year of the first harvest year.

e/ One year evaluation on two or more locations.

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